DeltaV™ Virtualization

This whitepaper provides an overview of Emerson’s DeltaV™ virtualization solutions for both on-line production systems and off-line systems for development, testing and training.
Introduction

This whitepaper provides an overview of Emerson’s DeltaV™ virtualization solutions for both on-line production systems and off-line systems for development, testing and training. This whitepaper is not intended to provide training material on virtualization, but rather provide an overview of how virtualization can be utilized in a process control system, and what specific Emerson products use virtualization technology.

The Challenge: A typical control system consists of a network of many workstations, servers, controllers and I/O subsystems. The setup and maintenance of multiple systems needed for development, testing, training and on-line production can be expensive and time consuming. Support for these systems is further complicated when multiple software and hardware releases must be maintained; especially when legacy operating system (OS) software is not supported on newer replacement workstation hardware.

The Solution: Virtualization offers many compelling benefits including less hardware to buy and maintain, increased configuration flexibility, higher availability, extended system life, and optimal use of computer resources. DeltaV Virtualization is an effective solution for development, testing, training, and maintenance of your DeltaV system. With virtualization, workstations and control system nodes can be run from a common host computer. And DeltaV Virtual Studio makes it easy to set-up new virtual workstations and control system components with little or no virtualization experience.

The Benefits: DeltaV Virtualization benefits include project flexibility, enhanced simulation and training, smaller footprint and energy consumption, reduced hardware and lifecycle costs, higher availability and extended system life. Project teams can easily add workstations and simulate processes with virtual I/O. Operators can be trained on a virtual process control system. System upgrades are easier because hardware and software upgrades may be implemented independently. That means legacy control systems can upgrade computer hardware without software upgrades.

Our Vision: Emerson’s vision is for virtualization to be integrated within DeltaV system such that the average control system administrator can set-up, operate and maintain their DeltaV system without extensive virtualization knowledge or experience. Development, testing and training systems will be completely virtual, with no controller or I/O hardware required. For on-line production, you will recover effortlessly from workstation or server failures with minimum disruption. Software upgrades will be fully checked out in a virtual environment prior to commissioning, or you can continue running your legacy software on newer virtual computer hardware without software upgrades.

Virtualization Applications for Process Control

Emerson is aggressively pursuing the use of virtualization technology in our DeltaV system product line. Our goal is to make virtualization transparent, so that control system users and administrators can easily realize the power and benefits of virtualization without the need to be IT experts with virtualization experience.

For readers who are not familiar with virtualization, a few basics concepts will first be addressed.

What Is Virtualization?

Put simply, virtualization is a way to “encapsulate” a computer, including its operating system and applications, so that it can be easily run on a Host Computer. For example, your existing laptop or desktop PC can be converted into a virtual PC that can be copied and run on another host computer. This virtual PC, or virtual machine (VM), is just a file that contains everything needed to boot and run your applications, except the hardware. To run a virtual machine you need a virtualization software layer that provides the mapping between the virtual machine and your host machine hardware, including network connections, USB ports, and other peripheral devices. Figure 1 illustrates the concept of a virtual machine running in a host computer.
It is also possible to run multiple virtual machines from a host computer; in this case, the host computer is typically a server class machine with lots of memory and CPUs. The virtual machines can have different operating systems (e.g., Windows 7 or Server 2008) running many different applications.

The host can have a full operating system, like Windows Server 2016 or often when you have a dedicated host computer running multiple virtual machines, you can just use a “bare metal” operating system (e.g., Windows Hyper-V Server 2016) to support the VMs. The “bare metal” option provides a lower cost, less overhead, easier to maintain and more secure environment for your virtual machines.

**Why Use Virtualization in Distributed Control?**

Virtualization is rapidly being adopted in many different industries, for many different reasons. When Emerson started our virtualization program we wanted to make sure we addressed the needs of our specific process control industry, which are considerably different than the needs of other industries that use data centers and are concerned with large amounts of transactional data.

To understand our customer needs we conducted many interviews and surveys and found the main motivating factors were cost effective workstation deployment and flexibility/ease of use.

**Cost effective workstation deployment**

The main customer drivers for more effective workstation deployment were to reduce the number of workstations in an effort to lower hardware, installation and maintenance costs. Workstation consolidation was particularly important for customers using many underutilized servers where virtualization can significantly improve hardware utilization. Fewer workstations also mean a smaller footprint which is very important to customers with limited control room space like on off-shore oil rigs or floating processing plants. Also noted, but less important, were the potential energy savings resulting from less power and cooling required.
Flexibility and Ease of Use

Virtualization also provides the flexibility to easily add and remove workstations, which is especially important in development or training systems where you may frequently need to set-up and tear down systems. Virtualization also makes it easy to support multiple systems, on multiple software releases, with the same virtualization hardware. For example, an engineering center may need to support three different DeltaV system releases for eight different plant locations. With virtualization, they can store VMs for each facility and quickly load them when necessary for troubleshooting problems or making modifications to existing applications. Virtualization also allows customers to be more hardware independent so that they can update hardware and software independently.

*Figure 2* shows a Dell PowerEdge VRTX blade server with integrated storage which runs up to 40 virtual DeltaV workstations running in four host blade servers.

Other compelling reasons our customers gave for wanting to use virtualization:

**Improved Support**

Central engineering groups, or vendor support centers, can easily set-up virtual test systems to provide non-intrusive remote maintenance and troubleshooting support. Virtual machines with field system configurations can be created and tested without disrupting process operations. Virtualization can also be used to test system upgrades and identify problems before the upgrades are implemented on-line.

**Extended System Life**

Many customers are also motivated to use virtualization to extend the life of their existing legacy system and minimize the number of software upgrades due to hardware obsolescence. With virtualization you can replace obsolete workstations and upgrade your computer hardware without upgrading your application software.

**Availability**

Virtualization is seen by many as a way to improve availability, providing faster recovery from workstation failure. Virtual machines are easily rebooted on spare host computers, or automatically restarted when implemented in a high availability virtual environment.

**Industry Concerns**

From our interviews and surveys, we also found that our customers have a number of concerns with using virtualization.

**System Complexity** - Customers with limited IT expertise have a big concern with adding system complexity. Although virtualization is tantalizing for IT professionals, many customers don’t want to rely on IT experts to maintain their control system. The message was clear – It needs to be Easy.

**Reliability and Performance** - There is also concern with reliability and performance of virtual machines vs. physical machines. This is an area where Emerson has done a lot of research and testing to insure any virtual solution we provide meets our requirements for performance and reliability.

**Vendor Dependency** - Some customers have a reluctance to add a layer of virtualization software that might malfunction, require additional attention, or may create dependence on another software vendor.

**DCS Vendor Support** - By far, the biggest concern from our customers is that they want the DCS and Application Vendors to provide support for their virtual solutions. If a problem occurs with a virtual DeltaV system, they want to contact Emerson for a single point of support.
Where to Use Virtualization in Distributed Control

Clearly the interest in using virtualization for process control is growing. However, our industry is inherently risk-adverse and cautious in adopting new technologies like virtualization. Some applications, like off-line development systems, are obvious applications which are low effort and high return. Applications for on-line process control also provide attractive benefits but are not as readily accepted by conservative users.

In an Emerson survey of customers interested in using virtualization we found:

- Over 90% want to use virtualization for their off-line test and development systems.
- Over 80% want to use virtualization for operator training systems,
- Over 50% are ready to use virtualization for on-line operator workstations and application servers.

Off-line Systems for Test, Development, and Training

Operator Training Systems

Virtualization is ideal for operator training systems (OTS). These systems typically do not include controller or I/O hardware and use workstation PC’s for operator consoles, application stations, and process simulators. The application stations are used for running the control modules in a workstation based controller, and process I/O is simulated by a PC based process simulator. Therefore there are no physical controllers and I/O subsystems included in a typical operator training system. Figure 3 shows a typical operator training configuration using DeltaV Simulate Multi-node with a Professional PLUS (ProPlus), 4 Operator Stations (OSN), 3 Application Stations (ASN), and a process simulator (MiMiC).

With virtualization, all of the OTS computers can be run as virtual machines in one or more host computers. This capability is particularly useful because training systems often are needed to support multiple process units and different versions of the DeltaV system. Virtual machines can be created for these different units and control systems and activated in the host computer when needed, allowing the same computer hardware to be used for multiple OTS applications.

Virtual OTS also provides other benefits such as smaller footprint, easy connection to remote thin clients or existing PC’s on a company LAN, and easy creation of additional operator training consoles as needed.
Development and Test Systems

As with OTS systems, a development and test system can have all the DeltaV workstations (Professional PLUS, Application, Professional, and Operator) virtualized on one or more host computers. With development and test systems however, it is important to checkout the I/O assignments, a task traditionally performed with actual controllers and I/O cards, or simulated I/O via a Virtual I/O Module (VIM) card. The virtualized DeltaV workstations can communicate on the DeltaV network to actual controllers and I/O hardware; however, we have also virtualized the controllers and I/O subsystems to enable a development / test system that does not require control hardware. For more information, see the product data sheets for Virtual CHARMS IO Card Simulation, Virtual Ethernet IO Card, and Virtual Machine Controller Simulation.
Starting with DeltaV v13.3, you can also create virtual machines for development and testing of DeltaV SIS with Electronic Marshalling, and DeltaV Virtual Ethernet I/O Cards. For DeltaV SIS, virtual machine templates are available for the SZ controller, Charms Smart Logic Solver (CSLS) and Local Safety Network Bridge (LSN). For more information, see the product data sheets for DeltaV SIS with Electronic Marshalling – Virtual Simulation, and DeltaV Virtual Ethernet I/O Card for Real-Time Smart Device Control/Data Integration and Simulation.

One benefit of a completely virtualized test and development system is that the controller and I/O hardware can be sent to site for early wiring and I/O checkout. Performing the FAT with virtual hardware, in parallel with on-site I/O set-up, can potentially reduce a project schedule and enable commissioning earlier.

Another benefit of a virtualized development and test system is that a single system can be used to develop and maintain multiple control systems with the same computer hardware. This can be a significant savings and flexibility advantage for central engineering departments and project teams.

![Source](image.jpg)

**Figure 6 – Virtual Development and Test System.**

### On-line Systems for Distributed Control

#### DeltaV On-line Workstation Virtualization

Virtualization also delivers benefits for on-line production systems. **Figure 7** shows a typical on-line system architecture, which has numerous Operator stations and Application stations. In this example, we have 8 Operator stations, 4 Application stations and a ProfessionalPLUS station.

With virtualization you can consolidate these 13 workstations into just a few host servers.

How many virtual machines you can run in a host server depends on the host resources, the virtual machine loading, and the virtual machines availability requirements. For example you may want to spread the operator stations used in one plant area between two or more servers to minimize disruption if a server goes down. However with virtualization, if a server does go down, it is much easier to get back on line, either manually or with an automated high availability solution, because you can store the virtual machines on a Storage Area Network (SAN). With virtualization High Availability (HA) technology you can have virtual machines automatically failover to a backup host in the event of primary host failure. You can also utilize existing Application Station redundancy for critical applications by running two paired Application station virtual machines in separate host servers.

**Figure 8** shows a DeltaV system architecture with virtualization using host servers, thin clients and a Storage Area Network.

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(SAN). In a traditional virtualization environment you would mount all the host servers, SAN and network switches in a cabinet to consolidate workspace and minimize footprint. With Emerson’s integrated hardware platform using Dell’s PowerEdge VRTX you can consolidate all this virtualization hardware into a small tower or 5U rackmount form factor.
DeltaV Virtualization Overview

Emerson is committed to providing DeltaV virtualization solutions for both on-line production systems and off-line systems for development, testing and training. The following sections describe the Emerson’s DeltaV virtualization solutions including:

- **DeltaV Virtual Studio** to provide easy setup and maintenance of virtual DeltaV environments, for both on-line and off-line applications
- **DeltaV Virtualized Control Hardware for Development and Test Systems**, including virtual CHARM I/O Cards, Ethernet I/O Cards, Virtual Machine Controllers and SIS control hardware simulation
- **DeltaV on VMware** for Off-line Systems

For more information on virtualization hardware options, please see [DeltaV Virtualization Hardware](#) product data sheet.

**DeltaV Virtual Studio**

DeltaV Virtual Studio is an integrated DeltaV system application environment designed for easy implementation and management of virtual DeltaV control systems for both off-line and on-line production systems. Most virtualization management software is complicated because the tools are generalized to support many different applications and markets. DeltaV Virtual Studio is designed specifically for virtualization of process control systems and has a workflow and feature set which is easy to use and understand by the typical process control engineer.

DeltaV Virtual Studio puts all the virtualization functionality you need into a simple DeltaV application.

- Create virtual networks and add host computers
- Create, start, stop and move DeltaV VMs
- Allocate virtual machine resources
- Define high availability and disaster recovery scenarios
- Monitor virtual machine status

![Figure 9 - Example VM Template Dialog.](#)
Logical and Physical VM Assignments

DeltaV control systems have both a physical and logical orientation, allowing control modules to be assigned to both logical plant areas and physical control hardware. DeltaV Virtual Studio also supports a logical and physical paradigm which allows you to assign your DeltaV virtual machines to both physical host computers and logical groups or plant areas. Physical assignments make it easy to allocate your VMs across multiple hosts and move VMs between hosts for resource load allocation and high availability. Logical group assignments allow you to easily manage and distribute physical resources used for specific process units or plant areas.

DeltaV Virtual Machine Templates

DeltaV Virtual Studio also makes virtualization easy by using DeltaV virtual machine templates. These templates allow you to easily add virtual workstations and controller hardware (for off-line use) from a single configuration dialog (see Figure 9). With a few clicks you can create a new DeltaV workstation in just a few minutes, without additional software installation.

A DeltaV template is a virtual machine with the operating system and DeltaV software fully installed. The virtual machine is then generalized to remove specific DeltaV and network configuration information. To create a new DeltaV VM, DeltaV Virtual Studio will complete the DeltaV workstation configuration, create network connections and add the VM to the selected DeltaV network.

DeltaV VM templates are available for all supported DeltaV workstations. DeltaV workstation templates also have an option to include associated AMS software if desired. All DeltaV templates include standard DeltaV release software. Additional hotfixes may be applied to the DeltaV VMs after instantiation. Customized templates can be created for the updated DeltaV VMs. Templates are also available for virtual DeltaV control hardware nodes (for off-line simulation use only) including controllers (S-series, M-Series, and PK), I/O cards (CHARM and EIOC), and SIS nodes (SZ Controller, CSLS, and LSNB).

DeltaV Remote Clients using Microsoft Terminal Services are also supported using DeltaV server VM templates. DeltaV Remote Client sessions provide the same functionality as DeltaV Operator and Professional Stations but enables multiple sessions using a single server operating system VM. The recommended architecture for full-time operator workstations uses single client desktop VMs (e.g., Windows 10). DeltaV Remote Clients sessions may also be used for full-time operator stations with the understanding that multiple session on a common server OS have inherent dependency risks. These risks may be minimized by utilizing DeltaV Virtual Studio High Availability and limiting the number of sessions per server OS (e.g., two sessions for critical operator stations). For more information, see the DeltaV Remote Client product data sheet.

Easy Network Connections

DeltaV Virtual Studio makes it easy to create and manage DeltaV virtual networks. A host set-up utility will automatically create virtual switches for your defined DeltaV system. Or you can manually add or edit virtual networks on your host servers as needed. Multiple DeltaV networks are supported for systems which encompass multiple systems. Figure 10 illustrates DeltaV virtual network connections.

DeltaV virtual machines are easily added to a DeltaV network because their templates come with predefined DeltaV network connections. A simple drop down menu allows you to connect a virtual DeltaV machine to its respective DeltaV network.

High Availability and Disaster Recovery

For on-line production control systems, fast recovery from system failures is important to insure maximum uptime. DeltaV Virtual Studio supports both High Availability (HA) and Disaster Recovery (DR) features to maximize reliability and minimize the Mean Time To Recovery (MTTR) after a failure.
High Availability includes automatic failover of virtual machines from a primary host to a secondary host in the event of primary host failure. High availability is implemented using a server failover cluster and shared storage (e.g., Storage Area Network – SAN).

When a host failure occurs, DeltaV Virtual Studio will automatically move the virtual machines that were running on the failed host, to a specified secondary host. The virtual machines are automatically started on the backup hosts if desired. DeltaV Virtual Studio also supports Live Migration of the VMs from one host to another, while the VM is running.

DeltaV Virtual Studio also supports disaster recovery with automatic virtual machine snapshot back-ups being saved every five minutes to a remote backup server. DeltaV Virtual Studio utilizes Microsofts VM replication which is a standard feature in Windows operating systems.

To maximize reliability you can implement both High Availability and Disaster Recovery to take advantage of both failover clusters and VM replication. In this case, High Availability provides very fast recovery from a host failure, and VM Replication protects against a disaster in which the shared network storage or failover cluster fails. Figure 11 illustrates a typical configuration for on-line virtualization which supports high availability.

High Availability and Disaster Recovery are also supported in the DeltaV Integrated Hardware Platform for Virtualization utilizing the Dell PowerEdge VRTX. For more information, see the virtualization whitepaper DeltaV Virtualization – High Availability and Disaster Recovery, and the product data sheet for DeltaV Virtualization Hardware.
**Virtualized Control Hardware for Development and Test Systems**

Emerson’s vision for the development system of the future is to have all control system components available as virtual machines, so that you do not need any physical control hardware in order to configure systems, develop applications, and perform rigorous testing (FAT) including I/O assignments. Virtual machines are available for controllers (S-series, M-Series, and PK), I/O cards (CHARM and EIOC), and SIS nodes (SZ Controller, CSLS, and LSNB). See the DeltaV Virtual Studio product data sheet for more information.

**Virtual CHARM I/O Card Simulation**

DeltaV Virtual CHARM I/O cards provide all the simulation functionality as real CHARM I/O cards running in simulation mode. Each virtual I/O card runs in a separate virtual machine on a host computer. Virtual CHARM I/O cards are supported with DeltaV Virtual Studio and VMware virtualization environments.

Once the virtual CHARM I/O cards are installed and connected to the DeltaV network, you can commission the virtual CHARM I/O card in the same way you commission real CHARM I/O cards. Once commissioned, you can provide simulated I/O using the DeltaV CHARM Simulate application or provide simulated process I/O via MiMiC using OPC. Virtual CHARM I/O cards must be assigned to either a real or virtual controller. Simulated CHARMs are not supported for control modules assigned to run in a DeltaV Application or ProPlus workstation.

**Virtual Machine Controller Simulation**

DeltaV virtual machine controllers for S-series, M-series, and PK controllers enable you to develop and thoroughly test control configurations without physical controller hardware. These virtual machine controllers, called VM Controllers, run in a host computer and are configured and behave the same as physical controllers. Configuration is the same because they use the same software as the physical controller, but the software runs in a virtual machine. When a virtual controller is created and connected to a DeltaV system, it can be commissioned and used for I/O checkout the same way you would use a physical controller.

The DeltaV VM Controllers are completely separate from the DeltaV workstation-based control software (a.k.a., “virtual controller”) which allows you to assign and execute modules on a DeltaV Application or ProfessionalPlus workstation. The DeltaV workstation control software requires a full DeltaV workstation to be installed in order to run. The DeltaV VM Controller is an independent controller, just like a physical controller, but runs instead as a virtual machine on a host computer.

For most off-line engineering activities, a VM Controller can be used as a substitute for a physical controller, except that the following features are NOT supported:

- Controller redundancy
- ACN redundancy (i.e., switch over of networks)
- Cold restart (power up configuration) and warm restart (tuning parameter restore)
- Controller diagnostics
- AMS device support
- Bus or serial I/O simulation

In addition, the VM Controller will not have the same performance metrics because of hardware differences. Specifically, the VM Controller should not be used to test loading. FRETIME, FREMEM, Module Execution Time, and Scan Period may be significantly different between a physical and a virtual controller. Virtual controller loading may also be subject to other operating system scheduling activities.

An important capability of the VM Controller is the ability to use simulated I/O with the same I/O assignments used by physical I/O cards and controllers. The Virtual Machine Controller supports simulated I/O for both Classic I/O and CHARM I/O cards. Simulated I/O can be easily accessed via OPC using DeltaV applications or Mynah’s MIMIC process simulator.
Virtual SIS Simulation

Virtual SIS simulation allows you to configure and test your safety logic without using the DeltaV SIS process safety system hardware. The virtual DeltaV SIS process safety system has a scalable modular architecture that is based on the CHARMs smart logic solver (CSLS) using Electronic Marshalling. In addition to virtualizing the CSLS and CIOC hardware, virtual machines are also available for the Local Safety Network (LSN) and SZ controller.

For more information, see the DeltaV SIS with Electronic Marshalling Virtual Simulation product data sheet.

DeltaV on VMware for Off-line Systems

DeltaV virtualization is also available on VMware for off-line development, test and training systems. The DeltaV system has been rigorously tested and achieved “VMware Ready” status for off-line applications. Emerson will test and validate all new releases of DeltaV on the latest release of VMware. We also have personnel trained on VMware in our support organization which can provide consulting services if you need help planning or implementing your virtual DeltaV system environments.

Licensing Considerations

DeltaV Virtual Studio

DeltaV Virtual Studio is a licensed application which requires a system access key (dongle) and associated license file. The license and dongle are included in the base DeltaV Virtual Studio license bundle. This license and dongle will enable DeltaV Virtual Studio across multiple hosts and DeltaV systems within the same virtualization environment, for up to 100 virtual machines. A scale-up license for more than 100 VMs is available.

DeltaV Licenses

A DeltaV system implemented with virtualization will require the same DeltaV licenses that are required for a traditional physical system. For example, you will still need licenses assigned to each DeltaV workstation whether they are virtual machines or physical workstations. The DeltaV licenses for DeltaV workstations will be tied to a DeltaV system ID as defined by the system USB access key (dongle). The DeltaV system access key (dongle) may be accessed on a physical DeltaV workstation, or through a USB IP Converter device which is available from Emerson and described in the DeltaV Virtualization Hardware product data sheet.

Microsoft Windows OS Licensing

The DeltaV workstations also require Microsoft Windows licenses. The DeltaV Virtual Studio templates include non-activated Windows operating system software which must be activated with a valid license before use.

Microsoft OS licensing for virtual machines is different for virtual server OS and virtual client OS machines. Virtual server OS machines require a Windows Server OS license (e.g., Windows Server 2008 or Server 2016) for each virtual server OS. Example DeltaV server OS workstations are for ProPlus, Application Stations, and Remote Client Terminal Services. Microsoft server OS licenses are included with the DeltaV Virtual Studio media bundles to cover the first VM created with each server template. Additional Microsoft Windows server OS licenses are available from Emerson.

Virtual Windows client OS machines (Windows 7) require a Windows Virtual Desktop Access (VDA) license subscription or Microsoft Software Assurance for each device which is accessing the virtual client machines. DeltaV Operator workstation is an example of a client OS machine. VDA subscriptions must be purchased separately from Microsoft or a Microsoft Partner. Proof of a VDA subscription or other valid client access license is required prior to shipment of DeltaV client OS VM templates from Emerson.

Microsoft server Client Access Licenses (CALs) are required for device connections to the host server. For multiple connections to a host server using Remote Desktop Connections, additional Microsoft Remote Desktop Services CALs (RDS CALs) are also required. All thin clients accessing DeltaV virtual machines on a host server will require both CAL and RDS CAL licenses. Microsoft CALs and RDS CALs are available from Emerson.

For additional information, please refer to Emerson’s white paper entitled “DeltaV Virtualization: Microsoft Licensing Guidelines.”
Resource Planning Guidelines

Virtual machines require host computer resources and are typically limited by available host CPU or RAM. The DeltaV Virtualization Installation and Planning Guide provides guidelines on how many virtual machines to assign to host computers based on the VM CPU and RAM requirements. These guidelines are for supported host hardware as specified in the DeltaV Virtualization Hardware product data sheet.

Support Services

All DeltaV virtualization products are fully supported by our Guardian Support Services. Virtual DeltaV systems are supported for both on-line and off-line applications, when these systems have been created using DeltaV Virtual Studio and are implemented on standard DeltaV virtualization hardware. Users can also run other applications in the virtual environment, and Emerson can provide consulting services to help include non-DeltaV applications in your DeltaV virtual environment.

Emerson provides limited support for DeltaV systems implemented on VMware platforms. We test every DeltaV release in a VMware environment and will support DeltaV customers using VMware for off-line, non-production applications (e.g., development, testing, and training). Emerson will provide implementation support, but the customer is responsible for configuration and implementation of DeltaV in the VMware environment. We will provide a reasonable effort to support DeltaV running in VMware; however, should we suspect that VMware or VMware implementation is causing an incident, the customer will need to either purchase Emerson support services to help troubleshoot and resolve the incident, or contact the appropriate VMware support provider.

Conclusion

In summary, there are many benefits which can be realized from using virtualization with your DeltaV system including cost effective workstation deployment, improved flexibility and productivity for your development and test systems, improved support, extended life for legacy systems, high availability, and disaster recovery.

Emerson is committed to providing an integrated DeltaV virtualization solution which is easy to use and provides the same performance and reliability that our customers have come to expect. Our virtualization program supports both VMware and Microsoft; VMware for off-line DeltaV systems, which have been certified “VMware Ready”, and Microsoft for both on-line and off-line integrated DeltaV virtualization using DeltaV Virtual Studio. We have also released several virtualization products including:

- **DeltaV Virtual Studio** to provide easy setup and maintenance of virtual DeltaV environments, for both on-line and off-line applications

- **DeltaV Virtualized Control Hardware for Development and Test Systems**, including virtual CHARM I/O Cards, Ethernet I/O Cards, VM controllers (S-series, M-series, and PK), and SIS nodes (SZ, CSLS, and LSNB)

- **DeltaV Virtualization Hardware** which is fully tested and supported for DeltaV Virtualization